



Title: L0 Safety Requirements	Owner: Bolyard	Date: 2019-09-06
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L0 Safety Requirements

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Change Record

Version	Date	Author	Affected Section(s)	Reason
I	2018-05-07	J. Bolyard	All	Initial draft
I.1	2018-09-15	J. Bolyard	All	Updated changes
2	2019-01-16	J. Bolyard	All	Updated changes from pre-decadal review RIDs
2.1	2019-01-25	J. Baca	All	Formatted document
3	2019-05-30	A. Lear	All	Prepared document for review
4	2019-05-31	R. Selina	5	Updated numbering scheme to match requirements management standards
A	2019-07-17	A. Lear	All	Prepared PDF for approvals & release
A.01	2019-08-30	J. Bolyard	2.1 and 5	Updated ADs, adding requirements to incorporate ADs by reference
A.02	2019-08-30	R. Selina	2, 5, 6.	Minor reformatting and typo corrections for re-release for StRR
B	2019-09-03	A. Lear	All	Prepare PDF for approvals & release as v.B



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1 Introduction

1.1 Purpose

This document intends to identify and capture the requirements for safety instrumentation, including hardware, software, and processes/procedures through the entire lifecycle of the Next Generation Very Large Array (ngVLA) effort. The requirements are intended to address the ngVLA efforts through design including reviews and prototyping, construction, commissioning actions, operation, and ultimate decommissioning.

1.2 Scope

The scope of this document extends to all Integrated Product Teams (IPTs), project reviews, work practices in labs and worksites, and subcontractors who provide documentation, procedures, or work at any ngVLA site.

1.3 Project Background

The ngVLA is a project of the National Radio Astronomy Observatory (NRAO) to design and build an astronomical observatory that will operate at centimeter wavelengths (25 to 0.26 centimeters, corresponding to a frequency range extending from 1.2 GHz to 116 GHz). The observatory will be a synthesis radio telescope constituted of approximately 263 reflector antennas, 244 of 18 meters diameter and 19 of 6 meters diameter, operating in a phased or interferometric mode. The antenna count includes antennas of the Long Baseline Array (LBA).

Construction and integration will be distributed across several existing NRAO and partner sites and in new facilities for this purpose. Operations will be conducted from both the VLA site and an Array Operations Center.

2 Related Documents and Drawings

2.1 Applicable Documents

The following documents are applicable to this Safety Specification to the extent specified. In the event of conflict between the documents referenced herein and the content of this Safety requirement, the content of the reference documents shall take precedence.

Reference No.	Document Title	Rev/Doc. No.
AD01	Environment, Safety, and Security Policy and Program Manual	Version D, October 2016
AD02	ngVLA Safety Risk Analysis Procedures	020.80.00.00.00-0002-PRO
AD03	OSHA General Industry Standard	29 CFR 1910
AD04	OSHA Construction Standard	29 CFR 1926
AD05	Environmental Protection Agency Clean Air Act of 1963	33 U.S.C.: Navigable Waters
AD06	Environmental Protection Agency Clean Water Act of 1972	42 U.S.C. ch. 85, subch. 1 § 7401 et seq
AD07	National Fire Protection Association, Consensus Standards, including the National Electric Code	



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3 Safety Scope

The Safety IPT Work Package includes safety, physical security, ongoing environmental protection actions, sustainability, and identification of associated risks. In the context of this document, “safety” includes all the aforementioned program elements. The Safety IPT scope includes assessing the requirements for all phases of the ngVLA effort.

Per NSF and in accordance with Executive Order (EO) 13693, the ngVLA effort must include means and methods for sustainable operations including utility usage, waste disposal, and recycling services. Sustainable operations include all facilities that are used as office, laboratory, information technology room or center, or dormitory space.

The Safety IPT crosses all IPT boundaries and is anticipated to be integrated into all design packages, operational procedures, and extends through the lifecycle of the ngVLA. The ngVLA Safety IPT will assist to ensure compliance with federal, state and local safety requirements. In addition, the effort will examine compliance with international standards, such as may be applicable in Mexico.

The proposed ngVLA project will require compliance with AUI policies for safe planning and management of large facilities. Consequently, there must be significant collaboration with all other IPTs as the requirements influence the Safety support needed. In this document, NRAO will determine areas that need further development to meet the collaborating IPT ngVLA requirements.



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4 Safety Across the ngVLA Lifecycle

All IPTs shall have a designated central point of contact for safety related issues and preparation of safety documentation for reviews. All personnel shall be alert to the need to identify potential safety hazards. Once identified, steps shall be taken to eliminate them, or reduce them to levels judged acceptable. The central point of contact for safety matters shall be the IPT safety liaison.

4.1 Safety IPT Review Support Requirements

The ngVLA Safety IPT is expected to support the Requirements Review for each subsystem to ensure that the relevant safety requirements are appropriate to the plan and meet the safety flow throughout the subsystem to the final system design. Additionally, the ngVLA Safety IPT will support the Preliminary Design Review to ensure that the design is mature enough from the safety perspective to proceed to prototyping and to ensure that the hazard analysis is sufficiently complete.

The following reviews shall have a Safety IPT member support:

- CDR to complete the safety compliance assessment and safety risk analysis.
- Manufacturing readiness review on final documentation and to offer signoff review of safe machinery.
- Test readiness review (TRR) to verify the test procedures are approved and the equipment and software under test are in their final deliverable configuration. The TRR shall include confirmation that the safety approval has been received.
- Product Acceptance to accept delivery from subcontractors, if applicable, and deliver the Safety Data Package documentation as part of the Acceptance Data Package. This includes but is not limited to:
 - Safety Procedures, if not described in the operator manual;
 - Declaration of Conformance; and
 - Hazard Analysis in accordance with ngVLA Safety Risk Analysis Procedures.

4.2 Design Activities

Safety assurance matters shall conform to the requirements defined in the NRAO Environmental, Safety, and Security (ES&S) Policy and Program Manual [AD01], and with site-specific safety directives.

Potential hazards shall be identified as a part of the normal design process and eliminated or reduced as far as possible. Safeguards shall be determined for outstanding hazards, which will reduce their possible effects to the lowest reasonable level in accordance with ngVLA Safety Risk Analysis Procedures. Any safety hazards that cannot be eliminated during the design process shall be reported to the Safety IPT Lead at the design review and ngVLA Project Office. Any progress shall be reported, including necessary proof that the relevant requirements have been satisfied.

4.3 Construction Activities

Construction work shall conform to requirements of the NRAO ES&S Policy and Program Manual [AD01] and Safety Work Plans provided by project contractors. Any design documentation affecting construction activities shall be provided in contract documents and procurement requirements. The Safety IPT shall support all construction activities with programmed meetings and reviews of contractor documentation, and shall sign off on acceptance of each completed construction site.

4.4 Operations Activities

Operations activities are not addressed in this document and shall follow NRAO ES&S Policies governing operational safety as described in the ES&S Policy and Program Manual [AD01].



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5 Safety Requirements

The following requirements shall be fulfilled *as a minimum* to achieve acceptable levels of safety across the ngVLA project.

Requirement ID#	Requirement Name	Requirement
SAF0028	Design for all lifecycle phase safety	The ngVLA shall be designed to achieve the highest level of personnel health and safety performance in all phases of the project lifecycle in accordance with standards applicable to the work.
SAF0029	Comply with ES&S manual	All aspects of the design and construction shall comply with the ES&S Policy and Program Manual.
SAF0030	Develop safe procedures	Where appropriate, each IPT shall develop procedures for personnel and equipment safety throughout the design, construction, and operation phases to address working conditions and use procedures, as well as identify the design features, that impact safety, environmental protection, and sustainability.
SAF0031	Follow safe design priorities	The priority for safe design shall address safety of personnel, followed by safety of equipment, and then the integrity of the data.
SAF0032	Follow mitigation order of precedence	The ngVLA system shall govern the hazard analysis and safety practices in an order of precedence as follows: 1) Design for minimum risk: The primary means for mitigating risk shall be to eliminate the hazard through design. 2) Incorporate safety devices: Protective devices shall be used as part of system design to reduce hazard risks to an acceptable level where possible. 3) Provide warning devices: When neither design nor safety devices can effectively minimize a hazard risk, devices shall be used to detect the hazard condition and alert personnel of its presence. 4) Procedures and training: Only when it is impractical to substantially eliminate or reduce the hazard, or where the condition of the hazard indicates additional emphasis, special operating procedures and training shall be used. All such procedures shall be fully documented.
SAF0033	Develop operational safety plan	An operational safety plan shall be developed and implemented before the commissioning phase starts.
SAF0034	Develop safety design specification	A Safety System Specification must be developed for both the design of individual system components and integration of system elements.
SAF0035	Use safety design specification for validation	The Safety System Specification shall be used in validation of the integrated system elements for system validation.



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Requirement ID#	Requirement Name	Requirement
SAF0036	Document safety compliance	Each completed design element must document safety compliance with the safety system specifications.
SAF0037	Describe process to achieve safe state	Each element must describe processes and address details to achieve safe state including potential sequencing of events.
SAF0038	Describe additional safety requirements	Each element must describe any additional measures required during validation, and describe consequences of failure to follow sequential processes.
SAF0039	Design facilities for safe operational use	The ngVLA Facility shall be designed to safely meet its technical requirements and operational specifications at the following physical locations. The Facility includes the main radio antennas, service areas, utility equipment, and all other infrastructure necessary to safely execute all the operational functions and secure all ngVLA assets. The Facility design must provide the space and functional equipment to maintain all system assets operating on the site.
SAF0040	Design controls for safe operation	The control capabilities throughout the system shall include both local and remote exclusive control modes for safe operation. Note this applies to any system that has potential for motion.
SAF0041	Ensure initial safe state for subsystem power up	Each Facility in the ngVLA Observatory shall implement a non-software-based safety system(s) in areas where injury or harm to personnel and or equipment can occur. Each subsystem when powered up shall be initialized into a known safe state without human intervention.
SAF0042	Ensure subsystems are standalone safe	Each subsystem shall be responsible for maintaining its own technical health, safety, and status without any other subsystem operational.
SAF0043	Address facility security in design	The project shall affirmatively address site and facility security needs in the design in accordance with the NRAO security policy(ies).
SAF0044	Address sustainability in design	The project shall affirmatively address sustainability goals in ngVLA design and ongoing operations.
SAF0045	Comply with the ngVLA Safety Risk Analysis Procedures	All aspects of the project design shall comply with the Risk Analysis procedures.
SAF0046	Comply with the requirements of OSHA General Industry Standard 1910	All general work activities (non-construction) are subject to the General Industry Standard. All work and workers shall comply with the 1910 requirements.
SAF0047	Comply with the requirements of the OSHA Construction Standard	All construction activities performed by the ngVLA project team and contractors shall be subject to compliance with the OSHA 1926 construction standard.



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Requirement ID#	Requirement Name	Requirement
SAF0048	Comply with the requirements of the Environmental Protection Agency Clean Air Act of 1963	All project elements shall comply with the requirements of the EPA CAA.
SAF0049	Comply with the requirements of the Environmental Protection Agency Clean Water Act of 1972	All project elements shall comply with the requirements of the EPA CWA.
SAF0050	Comply with the National Fire Protection Association, Consensus Standards, including the National Electric Code	All project elements shall comply with the requirements of the National Electric Code and applicable NFPA standards for fire and life protection.



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6 Appendix

6.1 Abbreviations and Acronyms

Acronym	Description
AD	Applicable Document
CAA	Clean Air Act
CDR	Critical Design Review
CFR	Code of Federal Regulations
CWA	Clean Water Act
EPA	Environmental Protection Agency
ES&S	Environment, Safety and Security
ICD	Interface Control Document
IPT	Integrated Product Team
ngVLA	Next Generation VLA
NEC	National Electric Code
NFPA	National Fire Protection Association
NSF	National Science Foundation
OSHA	Occupational Safety and Health Administration
RD	Reference Document
RFI	Radio Frequency Interference
TBD	To Be Determined
VLA	Jansky Very Large Array